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NOTES ON THE FRESHWATER FAUNA OF NORTH-WESTERN AUSTRALIA, ESPECIALLY THE KIMBERLEYS

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ABSTRACT

Notes on the freshwater fauna of north-western Australia including the Kimberleys are given based on fragmentary collections made May and June 1965. The collections do not support the idea that the region constitutes a distinct fluvifaunula province. Amphipods and stoneflies appear to be absent. Faunal diversity in streams seems low.

INTRODUCTION

The reason so little is known of the freshwater fauna of north-western Australia is clear: the region is amongst the most inaccessible and least densely populated parts of Australia. There are many reasons, however, why this region is of interest to biologists. It is well within the tropics and, for Australia, has a large annual rainfall with a marked and reliable seasonal periodicity; a great part of it lies over 500 m above sea-level (the Kimberley Plateau) and has many permanent surface waters; and it is isolated by extensive arid and semi-arid areas from southern regions of similarly plentiful permanent water, but lies only about 500 km from the well-watered island of Timor — part of a different zoogeographical realm.

A little information on the freshwater fauna is available from Dr E. Mjöberg's Swedish Scientific Expedition in 1910, and the more recent expedition to the north-western Kimberleys (Prince Regent River Reserve) in August 1974 (Miles and Burbidge, 1975). The present note summarizes information from a small number of samples taken incidentally in May and June 1965. Some frogs collected at the same time by Dr A.K. Lee (Monash

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University) are also considered. Some of the results have already been published: Bayly (1966) has discussed the calanoid copepods, McKenzie (1966) the ostracods, and Williams and Buckney (1976) the chemical composition of surface waters. This paper provides a synopsis of both published and hitherto unpublished results.

DESCRIPTION OF REGION

Several general accounts refer briefly to surface waters, e.g. those of Easton (1922), Field (1934), Christian and Stewart (1953), Morgan (1955), Patterson (1960), and Stewart and Speck (1960). Hydrogeological information upon parts of the Kimberley region is given by Morgan (1963), Passmore (1964) and Allen (1965). Jennings and Sweeting (1963) provide some chemical data for waters in the Fitzroy River Basin, but the most comprehensive account of the chemistry of surface waters is that of Williams and Buckney (1976). Summarizing their results, it is noted that the salient feature of all flowing waters in the Kimberleys was their extremely low salinity; most (5) had K_{18} values of < 25 μmhos, one had a value of 160 μmhos. Standing waters sampled likewise were very fresh; all had K_{18} values < 500 μmhos. Ionic dominances in both standing and running waters showed no consistent patterns. However, in general sodium or magnesium were the most abundant cations and calcium and potassium the least; sulphate was almost always the least abundant anion and bicarbonate the most. Williams and Buckney (1976) explain the low salinity of waters in the Kimberleys in geochemical and physiographical terms: the largely igneous rocks are Precambrian and long subject to leaching, and high average annual rainfall, rapid run-off and efficient drainage moderate evaporative concentrating effects due to high mean air temperatures.

Christian and Stewart (1953), Slatyer (1960), and Fitzpatrick and Arnold (1964) discuss the climate. It is arid-monsoonal in the north and semi-arid elsewhere — respectively, CA'w and DA'w in the Thornthwaite classification of climates (see Keast, 1959). Most rain falls November to April (summer). Part of the north-west has an annual average of > 125 cm, and most of the north > 60 cm; elsewhere it is 40 to 60 cm. Evaporation is always high, mean annual values ranging from *ca* 200 cm in the north to *ca* 260 cm in the south. Thus, mean annual potential evapo-transpiration greatly exceeds precipitation almost everywhere; only in a very small area of the extreme north-west is this not so. Mean monthly temperatures are continuously high; in January (mid-summer), they exceed 26°C; in July (mid-winter), they vary from < 21°C in the north to *ca* 18°C in the south.

Geological accounts for most of the region are given, *inter alia*, by Traves (1955) (Ord-Victoria area), Guppy, Linder, Rattigan and Casey (1958) (Fitzroy Basin), Speck (1960) (north Kimberley region and Fitzroy Basin) and Wright (1964) (West Kimberley region). In summary, the northern and central Kimberleys consist almost entirely of rocks of Upper Proterozoic age (mainly sandstones, quartzites, basalts, dolerite), the east Kimberleys and adjacent north-western part of the Northern Territory mainly of Cambrian and Proterozoic rocks (chiefly

limestones with interbedded shales and sandstones, quartzites), and the southern and south-western areas (mostly, the Fitzroy Basin) of rocks of Palaeozoic or Triassic age (conglomerates, limestones, sandstones, shales) and Quaternary alluvia.

In general, permanent surface waters are plentiful throughout the region, and particularly so in the north-west. Indeed, the Kimberleys, according to several authors (e.g. Patterson, 1960) is the best permanently watered area of northern Australia. Permanent running waters are mostly confined to the northern Kimberleys; elsewhere running waters occur only after the wet season with the exception of a few fed by perennial springs. Most standing waters lie in basins located along drainage systems and become part of such systems in the wet season.

METHODS AND RESULTS

Most collections were made with a pond hand-net in conventional manner or with a zooplankton cone net. Rotenone, a fish poison, was used once. The location of collections is indicated in Fig. 1, and, for brevity, localities mentioned in the text are referred to by number (except where frogs were collected). For convenience and consistency with McKenzie (1966) original station numbers are retained.

It has not been possible to identify all specimens to species rank, and this will remain the case for some years pending taxonomic revision of various groups. As definitive a list as possible is given in Table 1.

DISCUSSION

(a) Pisces

Fish were collected at eight localities (Table 1), but except at one (Sta. 599), no special effort was made to catch fish. At Sta. 599, the whole locality was poisoned with Rotenone. The fish recorded provided no surprises. Most occur widely in northern Australia (Lake, 1971) and some also in New Guinea. In any event there are no contradictions to the statement that Australia lacks primary freshwater fish (with two notable exceptions; cf. Lowe-McConnell, 1975). The fish collected indicate that this applies even in permanent and very dilute fresh waters in the tropical region closest to a zoogeographical realm *with* primary freshwater fish. The theraponid species recorded was not unlike *Scortum barcoo* and was initially identified as that species. Subsequently this identification was discounted.

(b) Amphibia

Eight species of frog were collected (Table 1). All but one have previously been recorded from the area (Cogger, 1975). The exception is *Uperoleia marmorata* (Leptodactylidae); the record of this species extends its known distribution considerably northwards from those areas in Western Australia from which it has previously been recorded (the species also occurs in south-eastern Australia). Of the other species recorded, one is widespread throughout most of Australia, three occur throughout northern Australia (and, of these, one also in eastern Australia), and three in the Kimberleys and the northernmost part of the Northern Territory.

(c) Reptiles

Two species were collected (Table 1).

Emydura australis was collected at three localities. It is endemic to the Kimberley region, though is not the only freshwater tortoise recorded there. In view of Cogger's (1975) recent statement that its habit is unknown though thought to be similar to that of *Emydura macquarii*, it is of interest to record that Sta. 587 was a deep permanent lake forming part of the Fitzroy River, 598 a permanent river, and 599 a large and probably permanent billabong associated with 598. Cogger's statement appears correct.

Crocodylus johnstoni was collected at Sta. 598. It was also reported from Sta. 587 (Geikie Gorge) but both this report and a report of the estuarine crocodile (*C. porosus*) in the same locality are unconfirmed by specimens. Cogger (1975) notes that both species occur in a wide arc across northern Australia, including north-west Australia.

(d) Hirudinea

A single freshwater leech was collected (Sta. 597). Its species identity remains unknown. It may be a member of the barbronid group but the typical copulatory pits of this group appear absent (L.R. Richardson, pers. comm., 21 September 1976).

(e) Mollusca

Three bivalve species were collected: a representative of the widespread *Corbiculina*, and two species of the mussel *Velesunio* (Table 1). With one exception, the records of *Velesunio* fall within known distribution ranges (McMichael and Hiscock, 1958). The exception is the record of *V. wilsonii* from Sta. 582; this record now links up the two known regions of distribution of this species in north-west Australia (McMichael and Hiscock, 1958).

Gastropods were collected thrice (Table 1). Though fragmentary, the record of *Lymnaea* in the Kimberley region east of the Ord Dam is of some medical and agricultural significance in view of the fact that certain species of the genus may serve as intermediate hosts for trematode parasites (cf. Charters, 1975). Note may also be made here of the recent remark by Wilson and Smith (1975: 97): 'No species of freshwater snails known to be vectors of schistosomiasis have yet been found in the Kimberley, but snails closely related are present.' Only one species of freshwater lymnaeid gastropod was collected by these authors from the Kimberleys who identified it as *Lymnaea tomentosa.* This species identification now seems to have been an error according to Dr B.R. Wilson (pers. comm., 8 December 1977). Studies on the identification of the Kimberley *Lymnaea* are proceeding at the Western Australian Museum.

(f) Sundatelphusidae

Freshwater crabs were collected at three localities. All were *Holthuisiana transversa* and fall well within the known range of that species (Bishop, 1963).

(g) Palaemonidae and Atyidae

One genus in each family was recorded (Table 1). The records extend the known generic distributions but in an expected fashion. Thus, the records of *Macrobrachium* relate to an area bordered north and south by previous records, and those of *Caridina* provide expected extensions to the record of its presence near Darwin (N.T.) (see Bishop, 1967).

The *Macrobrachium* specimens belonged to three species: *M. rosenbergi*, *M. tolmerum* and *M. australiense cristatum.* These showed clear geographical separation except that at one locality, 603, both *M. rosenbergi* and *M. tolmerum* coexisted. The occurrence of *M. rosenbergi* at this locality is not surprising for this species is known to penetrate fresh waters but require estuarine conditions to breed; locality 603 was not far from such conditions. *M. tolmerum* was found only in the northern part of the Kimberleys; *M. australiense cristatum* occurred in the more southern localities. Both *M. australiense* and *M. tolmerum* have previously been recorded from north-western Australia (Ord River) by Mr T. Walker (pers. comm., 4 August 1976), and these records and the present ones indicate that both species are more widespread in Australia than previously published records would suggest. The occurrence of *M. rosenbergi* is not the least surprising; the species is known from brackish or coastal fresh waters in south-east Asia

and Australia. In view of Riek's (1951) statement for *M. tolmerum* that 'on the size of the eggs one would be of the opinion that this was an estuarine species of the genus' it should be noted that all localities from which it was recorded in the Kimberleys were markedly fresh, and some were upstream of substantial waterfalls (on the King Edward River). There seems little doubt that *M. tolmerum* is a true freshwater species of *Macrobrachium*.

Caridina specimens appeared to belong to two species. Neither species unequivocally fits species descriptions of known Australian species, but it is noted that Riek's (1953) revision of Australian Atyidae is no longer considered adequate.

(h) Ostracoda

Ostracods were collected from 13 localities (Table 1). Sixteen species were recorded, 6 new to science. McKenzie (1966) has dealt with the material comprehensively. Here it need be noted only that all species belonged to known genera, and that the records of the European and African genus *Isocypris*, the Indonesian and African genus *Hemicypris*, and the southern hemisphere genus *Strandesia* were the first for Australia. The species records also included several previously known only from eastern Victoria.

(i) Copepoda

Of free-living copepods, only calanoids have been examined in detail. The results formed part of the basis of the paper by Bayly (1966) which reviewed the taxonomy and distribution of Australian species of *Diaptomus*. Two species of *Diaptomus* are known from Australia, *D. (Eodiaptomus) lumholtzi* and *D. (Tropodiaptomus) australis*. Of these, the former was recorded at fifteen localities and the latter at one (Table 1). All records considerably extended the known Australian generic distribution.

Boeckella triarticulata was recorded at two localities, both well north of the previously known generic limit. At one (Sta. 578, Lake Woods), *D. lumholtzi*, *B. triarticulata* and *Calamoecia lucasi* coexisted. This was the only locality at which *Calamoecia* was collected, indicating the absence of this genus from north-western Australia despite its presence in north-eastern Australia and New Guinea. The co-occurrence of *D. lumholtzi* and *B. triarticulata* does not invalidate the general thesis that *Diaptomus* is a genus of northern distribution whereas *Calamoecia* and *Boeckella* are genera of predominantly southern distribution.

(j) Cladocera

No attempt was made to collect Cladocera widely but a large collection from one locality (Sta. 596) was obtained. This contained a great variety of taxa: at least ten genera and twelve species (Table 1). One of the genera (*?Pseudosida*) and one species (*Pleuroxus ?reticulatus*) have not hitherto been recorded from Australia. Two species at least, *Chydorus barroisi* and *Ilyocryptus spinifer*, are common in Australia.

(k) Insecta

The insect collections are quite fragmentary. However, representatives of six orders were obtained (Table 1): Hemiptera, Odonata, Coleoptera, Ephemeroptera, Diptera and Trichoptera. Although these were obtained without special effort, determined efforts were made to collect plecopteran nymphs and adults. None was found (see Conclusions below).

Representatives of all the major aquatic Hemiptera families were found, namely Nepidae, Corixidae, Notonectidae, Naucoridae, Belostomatidae and Gerridae. With one exception, all taxa recorded are either widespread in northern Australia or are Australia-wide in distribution and thus of little zoogeographical interest apart from extending the known distributions of some forms. The exception is *Nychia ?marshalli*, a species widespread in south-east Asia. It has previously been reported from the Kimberleys (Hale, 1925) but is not found elsewhere in Australia.

Five odonate taxa were recorded: none is restricted to north-western Australia, and they occur widely beyond that region. Most Kimberley Odonata have distributions of this sort (Watson, 1974): indeed only 4 species are known from the Kimberleys alone. The remaining 53 are found also in the Northern Territory and New Guinea (4 spp.), north-eastern Queensland (1), the Northern Territory and north-eastern Queensland (46 — including some very widespread forms), and Hamersley Ranges (1). The same general comment applies to the two beetles identified to species.

Rather greater interest attaches to the limited (and damaged) ephemeropteran material. This included two separate species of Caenidae, one in the genus *Tasmanocoenis* (the only known Australian genus in the family), the other of uncertain generic position. It is very likely that one of these species, and possibly both, are new to science in view of Riek's (1970: 238) statement on the genus: 'The only Australian genus [of Caenidae], *Tasmanocoenis*, is found in Tasmania and on the mainland from the coastal plains to the subalpine zone of the Kosciukso Plateau; one species exists in

W.A.' (it is possible that the W.A. species mentioned is one whose description remains unpublished by Riek). Baetids have previously been recorded from the north-west of Australia (Riek, 1970).

TABLE 1

Fauna recorded

Taxon	Station numbers*†
Pisces	
Neosilurus glencoensis	599
Melanotaenia sp.	597, 598, 599
Ambassis agassizi	580, 597, 599
Madigania unicolor	598, 599, 607
theraponid sp.	578, 598
Glossogobius giurus	587, 599
Morgunda morgunda	587, 596, 599
Amphibia	
Litoria rubella	Top Springs, N.T.; Hayward Ck; Woodhouse River Crossing, W.A.; King Edward Lake
L. nasuta	King Edward River
L. rothi	Admiralty Gulf; Langi Crossing, Fitzroy River; King Edward River
L. inermis	Woodhouse River Crossing; Camfield River; King Edward River; 40 km N of Gibb River Homestead; Fitzroy River Crossing; Langi Crossing, Fitzroy River
L. coplandi	King Edward River; Admiralty Gulf; 40 km S of Wyndham
L. wotjulumensis	King Edward River
L. meiriana	King Edward River
Uperoleia marmorata	Gibb River Station
Reptilia	
Emydura australis	587, 598, 599
Crocodylus johnstoni	598
Hirudinea	
barbronid sp.	597

* See figure legends for details of position.

† Localities at which frogs were collected do not all correspond with other collecting localities. Original locality data are therefore given.

TABLE 1

Fauna recorded

Taxon	Station numbers
Mollusca	
Corbiculina sp.	597
Velesunio wilsonii	582, 587
V. angasi	597, 598
Plotiopsis australis	587
Lymnaea phillipsi (?=L. lessoni)	586
?Lymnaea sp.	597
Sundatelphusidae	
Holthuisiana transversa	576, 577, 595
Palaemonidae	
Macrobrachium rosenbergi	603
M. tolmerum	593, 595-599, 602, 603
M. australiense cristatum	580, 581, 587
Atyidae	
Caridina sp.A	593, 595-598, 602, 604
Caridina sp.B	587, 595, 597, 598, 603, 604
Ostracoda	
Ilyocypris australiensis	575, 576, 580, 583, 584, 590, 593
Newnhamia fenestrata	576, 592
Cyprinotus kimberleyensis	591, 592, 594, 599
Heterocypris sydneia	580, 581
Hemicypris cf. *fossulata*	580, 581, 591
H. megalops	580, 581, 599
Cypris cf. *bennelong*	575, 583
Isocypris williamsi	583, 584, 590, 593
'Strandesia' dorsoviridis	583, 590, 592
'Eucypris' cf. *oblongata*	591
Candonocypris fitzroyi	590
Cypretta cf. *turgida*	576, 590, 591, 596
Cypretta sp.	593, 594
C. bayli	583, 594
C. lutea	584, 592
Limnocythere aspera	599
Copepoda	
Diaptomus lumholtzi	575, 576, 578-583, 587, 588, 591, 593, 594, 606
D. australis	597
Boeckella triarticulata	578
Calamoecia lucasi	578

TABLE 1

Fauna recorded

Taxon	Station numbers
Cladocera	
?Pseudosida sp.	596
Chydorus barroisi	596
Chydorus sp.	596
Alona spp.	596
Biapertura affinis	596
Alonella sp.	596
Camptocercus sp.	596
Pleuroxus ?reticulatus	596
Simosa (=Simocephalus) sp.	596
Ilyocryptus spinifer	596
other macrothricids	596
Insecta	
Hemiptera	
Ranatra dispar	577
Nychia ?marshalli	587
Anisops nasuta	586
A. semita	586
Gerridae	586
Micronecta sp(p).	586, 580, 597
M. cf. *robusta* and *major*	575
M. ?halei	575
Agraptocorixa parvipunctata	604
Naucoris sp.	597
Diplonychus ?rusticus	597
Odonata	
Pantala flavescens	577
Hemianax papuensis	577
Hemicordulia tau	597
Nannophlebia sp.	597
Diplacodes haematodes	597
Coleoptera	
Dytiscidae sp(p).	575, 578, 580, 586, 587, 593, 597
Eretes sticticus	575, 578
Hydrophilus sp.	575
?Hydrocanthus australasiae	598
Ephemeroptera	
Baetidae	575
Tasmanocoensis sp.A	575
Caenidae (*non T.* sp.A)	580

TABLE 1

Fauna recorded

Taxon	Station numbers
Trichoptera	
Leptoceridae	597
Diptera	
Tabanidae	587

CONCLUSIONS

The faunal collections are too fragmentary for firm statements on the zoogeographical cohesiveness of the area or otherwise. However, as they stand they provide little support to the idea that north-western Australia comprises a distinct fluvifaunula region. Certain taxa do appear endemic to the region, but many form part of a widespread northern Australian assemblage of forms, and some occur, too, in the Indonesian Archipelago and beyond.

Two further, and rather more definite general points may be made. Firstly, specific searches were made for freshwater amphipods and plecopteran nymphs. Despite careful searches in a number of apparently suitable localities, no specimens were found. The apparent absence of plecopterans should be noted against the statement by Riek (1970: 317) that 'there are no records from the vast area of central, north, and north-western Australia, although there are probably some areas that would be suitable for stoneflies.' Bailey and Richards (1975) in their report on the insects of the north-western Kimberleys do not list any plecopterans amongst specimens collected.

Secondly, although most general faunal collections were fragmentary, at one locality, Sta. 597, a more thorough collection was undertaken. Here, the following groups were found (see also Table 1): Coleoptera, Odonata, Palaemonidae, Atyidae, Hemiptera, Ephemeroptera, Pisces, Reptilia. Notably absent were bivalve and gastropod molluscs, oligochaetes, and trichopteran, plecopteran and dipterous larval forms. The locality, a small stream, appeared permanent (as indicated by the presence of prawns), yet was remarkably depauperate in terms of faunal diversity *vis-à-vis* small permanent streams in south-eastern Australia. Possibly the extremely low salinity of the water (16 ppm) had an effect, but this is not regarded as a total explanation; Tasmanian streams as dilute have a much more diverse fauna.

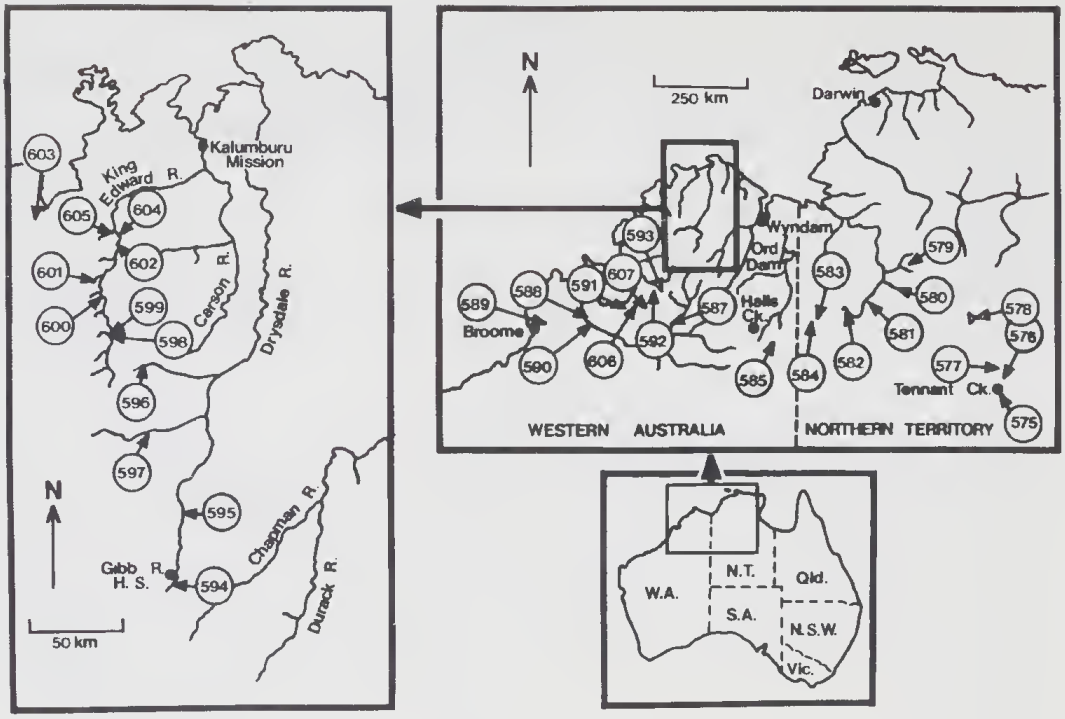

FIG. 1

Position of sample localities

Index to station numbers: 575, water-holes in Tennant Creek; 576, water-holes in Hayward Creek; 577, water-holes in Morphett Creek; 578, Lake Woods, near Elliot; 579, water-hole in creek at Top Springs; 580, water-hole in Camfield River; 581, water-hole in tributary of Victoria River, 16 km west of Wave Hill; 582, deep pool in creek bed, about 80 km east of Inverway; 583, shallow pool in creek bed, about 16 km west of Inverway; 584, small, bore-fed, dam about 200 m from 583; 585, Mary River, about 110 km east of Halls Creek; 587, large, deep and permanent lake in course of Fitzroy River at Geikie Gorge, near Fitzroy Crossing; 588, mouth of Fitzroy River at Langi Crossing; 589, artificial dam about 3 km east of Broome; 590, large but shallow water-hole near junction of Broome, Derby and Fitzroy Crossing roads; 591, small, bore-fed, dam about 80 km east of Derby towards Mount House homestead; 592, deep rock-hole, about 95 km west of Mount House homestead; 593, water-hole in bed of creek, about 40 km west of Mount House homestead; 594, temporary, shallow pool in creek at Gibb River homestead; 595, small rock-hole about 40 km north of Gibb River homestead; 596, billabong of Crossland River about 16 km north of Sarsfield (= Drysdale) Crossing and south of Couchman Range; 597, Drysdale River at Sarsfield Crossing; 598, King Edward River; 599, billabong about 1 km south of locality 598; 600, tributary stream of King Edward River about 20 km north of 598; 601, tributary stream of King Edward River, about 30 km north of 598; 602, King Edward River, about 3 km south of Falls; 603, small stream entering Montegue Sound; 604, small isolated water-hole in rock at Falls on King Edward River; 605, quiet backwater of King Edward River at Falls; 606, water-hole in Lennard River at Winjana Gorge; 607, pool in cave, Tunnel Creek.

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